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THE BEGINNINGS OF HUMAN HISTORY READ FROM THE GEOLOGICAL RECORD: THE EMERGENCE OF MAN[1]

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As now interpreted history means nothing if it does not present connected series in which every part contributes somewhat to the interpretation of all other parts or is in turn interpreted by them. Features of contrast may serve as markers for stages of movement and degrees of change, but the essential interest of the subject is embodied in the idea of continuity or unity.

The concept of evolution as we use it in science is only another form of expression for continuity in historic series presenting sequences of apparently different elements. It represents the idea of growth. It involves rate of development and nature of the forces controlling it. It interprets present conditions in terms of the past, and furnishes to some extent a basis of calculation for prediction of the future.

In the preceding lectures of this series your attention has been directed out over the stellar world, and back in time through certain evident transitions by which its existing stages have been reached. The earth which we inhabit has been shown to you shaping into its present form, and the living world upon it has been passed in review through numberless evolutionary changes leading up to its present highly differentiated, and relatively complicated phases. The mechanism of evolution has also been set forth as we now see it. Astronomer, geologist, paleontologist and biologist have all expressed the idea of growth.

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[1] Delivered before the National Academy of Sciences in April, 1918, as the sixth series of lectures on the William Ellery Hale Foundation.

While the passage from stellar to geologic evolution has consisted mainly in narrowing of view to special processes, the introduction of an organic or life sequence has involved a most difficult transition, seeming superficially of a qualitative type, and presenting one of the great problems barring our way to a full interpretation of nature.

Considering the evident physico-chemical and biological characters of man, resembling those represented in the general scheme of animal evolution, and taking these characteristics together with man's relatively advanced stage of intelligence and constructive ability, it has been natural to think of the human organism as the next member of a graded series beyond the stage seen in biological or paleontological history. This might of course be done without assuming relationship between man and nature. It is, however, logical to inquire whether there is not actually full continuity between the biological world and the distinctly human sphere. As humans, no problem of greater fundamental significance faces us in contemplation of the historical or origin sequence in nature.

At a time when our world has just emerged from a conflict involving the making of history of unexampled significance, it may seem that consideration of the beginnings of our story might well wait upon better opportunity for such luxury as speculation regarding an unchangeable past. This view we might well hold were it not clear that future world adjustments, brought immediately before us by the present crises, involve many heretofore little-heeded factors, among which are included those biological aspects of human life and social organization striking their roots down to the lowest strata of history.

Every nation with a clear vision now realizes that with the widely differing peoples of the earth brought in immediate contact by modern rapid transportation, by lightning communication, and by the reaching out of interdependent industries, international difficulties can be settled or prevented only through understanding of the nature, environment and needs of every nation and race. This comprehensive view of the world situation will not be alone the interpretation of the diplomat, of the international lawyer, or of the business man concerned primarily with trade for profit. It will necessarily include perception of the essential similarities and differences of race, understanding of racial and national psychology, of special abilities of peoples for accomplishment in particular directions, and of peculiar needs of races and nations. Together with these factors, which have their basis largely in heredity, we must know the true influence of environment, of culture and of language.

The knowledge which we require is such as can be reached only by the fullest attainable understanding of the true nature of every phase of the human type in every aspect of its being. As a part of the required information, it will be essential that we have clearly outlined the background of our entire history, setting before us the evidence as to what we are, by showing us how we came to be.

APPROACHES TO EARLY HUMAN HISTORY

Approaches to early human history have been made by many roads; one has been that of the investigator working his way back from present to earlier time by way of documentary history, and finding a lower limit in the beginning stage of written record set down by use of hieroglyphs or alphabets. We have also the approach through work of the philologist and the ethnologist suggesting relationships and origins through similarities of language and custom. Advance to still earlier stages of the human record are made by way of archeology, basing its method in part upon physical superposition of strata in determination of culture sequence. Carrying us still farther down is that aspect of paleontology connected on the one hand with the study of cultures through archeology, and on the other hand basing history upon succession of faunas and floras, and using the sequence of strata worked out by the carefully elaborated technique of the geologist. To these views there must then be added the speculations of the biologist upon relationships of the human family, which naturally follow a broad application of the evolution theory.

There can be no field of science which does not, in addition to its peculiar individuality, represent also the meeting place of other sciences, as, for example, chemistry is indissolubly connected with physics and is expressed in terms of mathematics. There are, however, few cases in which the information required for construction of the complete story has remained for a longer period so widely scattered and so sharply divided into the various elements needed for understanding of the subject, as have the materials used in constructing the beginnings of human history. As in the development of the relationships of many other sciences, starting from widely separated points, the student of documentary history, the philologist, the archeologist, biologist, geologist and paleontologist have all worked out from their special regions until the widening boundaries overlapping have given us the present field of early human history.

Consideration of that phase of the problem concerning the emergence of man or the beginning of human history is essentially then an archeological and paleontological problem read out of the geological record. The evidence as we know it unquestionably carries us back into records representing geological periods long antedating the present age in the earth's story. Although no sharp distinction exists between the methods of the archeologist and those of the geologist, it seems clear that the interpretations of the geologist and paleontologist with the cooperation of the biologist must be the dominant elements in obtaining our understanding of the earliest stages of human life.

It is the purpose of the two lectures given at this time to deal with that portion of the historical series covered by the *emergence* of man and the stages of his history before the dawn of civilization. While the question is essentially comprised within the realm of geologic and paleontologic research, it is necessary to consider also such evidence as may be secured from other sources indicating the place of the human type in the natural world, with whatever data may be found to furnish suggestions concerning the origin and ancestry of man. The inquiry concerns specifically a particular portion of actual history, for which the explanation or cause must be furnished by evidence secured on other lines of thought.

Biological Position of the Human Type

A study of the beginnings of human history, considered from the point of view of an investigator passing in review the evolutionary process, involves the biological relationship of man to other groups or organisms. Before presenting the evidence of human history from the paleontologic and geologic side it is desirable to set up as a background such information as we have from other sources concerning the possible biological relationships of the human family. These considerations are taken up with a view to determining their value in interpretation of man's place in nature, and the possibility of his growth or evolution out of the natural world. They comprise:

1. The question of existing human differentiation. Do laws of variation, such as are found in other groups of organisms, obtain also among humans? In other words, is a biological scheme of classification naturally expressed within the human group?

2. The problem of geographical distribution of human variations with special relation to the question of origin and classification of such differing types.

3. The problems of comparative anatomy and physiology, including consideration of the question whether man's body is structurally similar to that in the higher animals.

PHYSICAL VARIATION IN THE HUMAN GROUP, AND CLASSIFICATION OF SUBGROUPS

Bringing into review the whole range of variation of the human family in all of its aspects, the differences in structure and in other characters, as color, seem to many biologists comparable to the grades of distinction separating species of horses, wolves, bears, monkeys, and other mammals. There is, to be sure, the unending discussion whether the various *kinds* are to be distinguished as varieties, species or genera; but the settlement of this question is of the same nature as the determination whether the species of one author writing on modern mammals are always comparable with those of another. There may, however, be no difference of opinion regarding existence of these distinctions, or that they represent the natural expression of variation or evolution in these groups of organism.

No biologist coming down from Mars would hesitate to divide the human family into groups comparable to those of other mammals. Though there might be a difference of opinion among the Martians on the question whether certain divisions of the human type should be designated as varieties, species, genera or families, it is probable that the Martians would construct similar classification schemes, their divergence of opinion concerning mainly the question as to nomenclature of the divisions in their similar plans. So the biologists and anthropologists of our own world to-day, without regard to minor differences of opinion, classify the human group. Each division with its peculiarities and its assumed relationships, and each perhaps possessing among its peculiarities possibilities for advance of the world interest not open in the same measure to any other group.

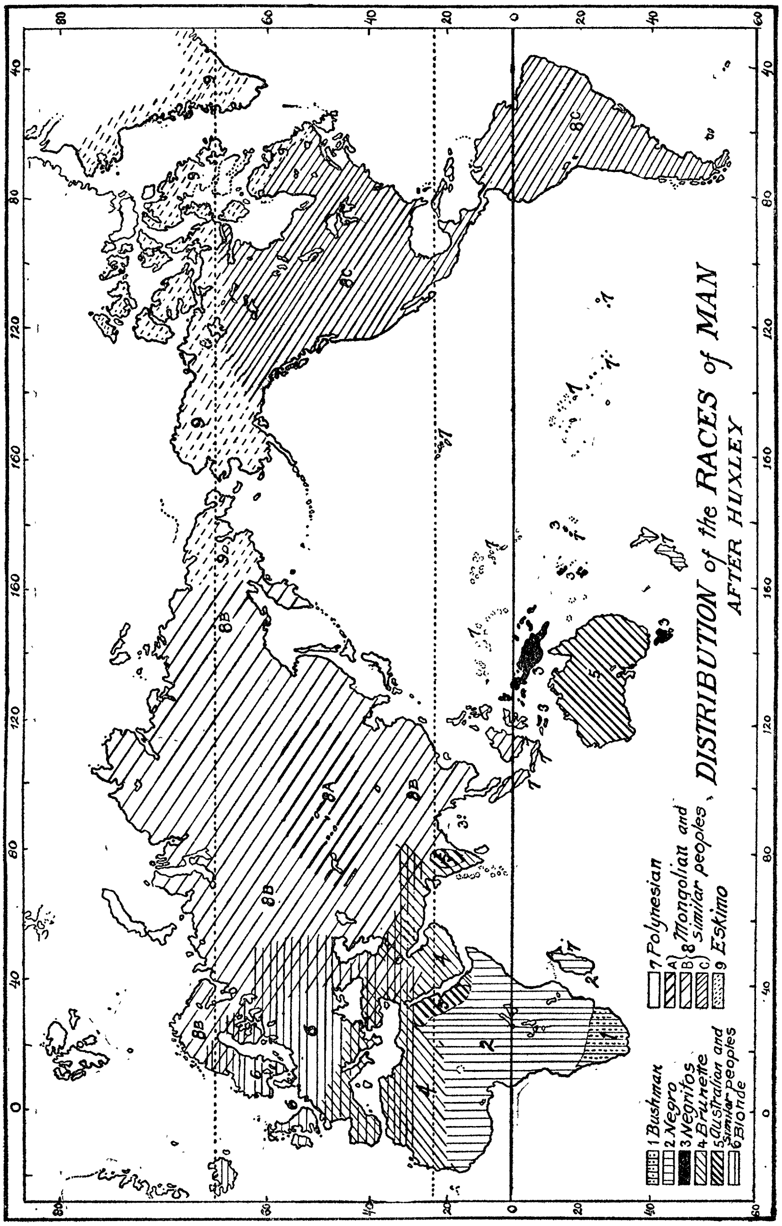
GEOGRAPHICAL DISTRIBUTION

Along with other natural relations, the geographical distribution of man presents a most interesting resemblance to the situation obtaining generally among the higher vertebrates. We frequently find that a map showing distribution of the members of a group of mammals or birds represents in fairly clear outlines a classification of the subdivisions such as would be made on the basis of morphology. The forms exhibiting the closest resemblances are geographically nearest, but not in the same place, and those that are most widely separated in characters are generally far apart geographically. The whole scheme of distribution when checked against geological history generally shows the group gradually radiating from its place of origin and differentiating more widely as the distribution extends. As shown by W. D. Matthew it is not necessarily true that the peripheral types are the most specialized, they may be primitive forms pushed out from the point of origin, but in general wide geographic separation seems to mean wide morphologic difference. In the case of man we find this geographic grouping of similar types, the geographic separation of more widely differing groups, and the pattern of distribution corresponding in general to the grouping of varieties or species of the human type according to morphological characters.

In the distribution of human types a most striking suggestion bearing upon the relation of distribution to variation is presented in the physical variation among the inhabitants of North and South America. Although there are between one hundred and two hundred linguistic groups in this area, the physical types throughout both continents are not widely different and are very close to those of Asia, the nearest land. A student of modern mammals, equipped with experience in tracing out the history of distribution of groups, would not hesitate in the case of non-human mammals to state that factors of distribution and variation such as we see in the case of man in America indicate that the organisms concerned have been on this continent such a short time that there has been little opportunity for physical differentiation to take place; and that the American forms are evidently derived from an Asiatic source. It may be desirable to mention in anticipation, that the evidence of geological history indicates that man now highly differentiated in the Old World has been present there for a long period, whereas in America, with relatively little differentiated human types, the question as to antiquity extending back as far as the geological period preceding the present is still under vigorous discussion.

STRUCTURAL RESEMBLANCE OF MAN TO THE HIGHER ANIMALS

The physical characters of man generally resemble those of the apes so clearly that discussion of this relationship inevitably resolves itself into a search not for similarities but for differences.



DISTRIBUTION of the RACES of MAN
AFTER HUXLEY

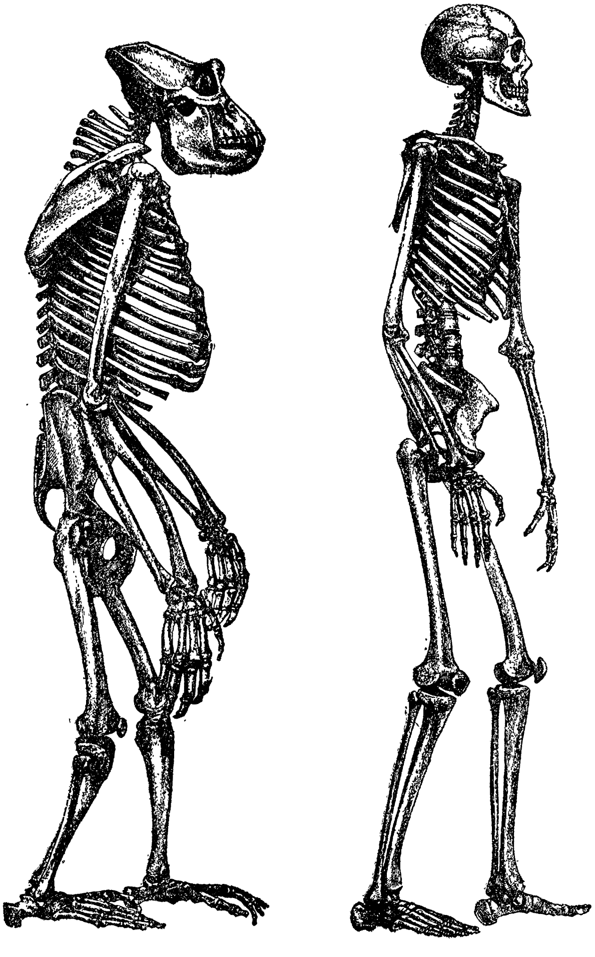
A consideration of features in the anatomy of man assumed to be indicators of relationship requires that reference be made to peculiarities in the development of certain parts of the skeleton which have been held to represent characters of mammals or of reptiles, and to be present in man because of his descent from these lower types. It has been assumed that, among others, such characters are seen in the presence of separate bones representing ribs attached to the neck vertebræ, and present between the pelvis and the vertebral column of man. These elements correspond to normal functioning bones of the reptile skeleton. They originate and develop to a certain stage in man as in the reptiles, but later fuse with adjoining bones.

It is possible that some of these structural features have no relation to the question of ancestry of the human skeleton. On the other hand, as in the case of the ribs lying between the vertebral column and the pelvis, and in the growth of the first two vertebræ, there is every reason to believe that the mode of development corresponding to that of the reptiles in these portions of the body is not related to specific needs of the skeleton of man considered either as completed or in process of growth; but that it represents rather a mode of development initiated in a pre-mammalian stage, and persisting in man by reason of the fact that even at this stage in evolution it offers no distinctly unfavorable features. It should also be noted that the mode of development of these elements seen in man is common throughout the mammals, and is most strongly expressed in those forms which most closely approximate the characters of the reptiles.

The anatomical characters distinguishing us from the anthropoids are generally considered to be most sharply expressed in form and dimensions of the brain and skull, and in form and function of the posterior extremities. It is probably unnecessary to proceed farther than to mention the difference between the brain capacity of less than 600 c.c. in a gorilla bulking larger than a man, and an average of about 1,500 c.c. in a Caucasian male, or a minimum of about 950 c.c. for a female Veddah, one of the lower races. Difference in brain capacity is accompanied by skull distinction of which the most readily recognized character is seen in the relatively large size and prominence of the jaws in the apes.

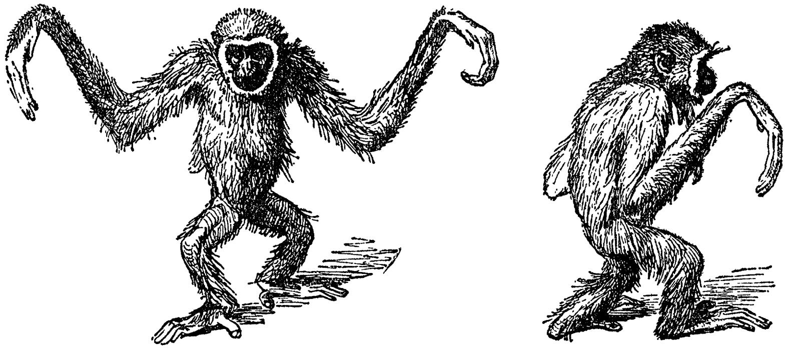
In some respects the difference between man and the apes seems as clearly expressed in the limbs as in the brain, especially since the difference is not merely one of degree, but is in the limbs a distinction of kind and of function. In most apes the relatively long fore-limbs are the principal structures for locomotion, which is by swinging through the trees, and to some extent the hands of these limbs serve the head, though the thumb is not generally opposable. The hind limbs of the apes are used for grasping and the feet with opposable first toe serve as hands.

In man the relatively long posterior extremities are used solely for walking. The anterior extremities with opposable thumb of the hand serve the head, and as one among many other functions they may be used for climbing. The opposable thumb is specialized to a high degree and freedom from use in locomotion permits the hands a great development of skill in many directions. In apes there are really four hands, but the pair with opposable first digit is situated on the portion of the body farthest from the head, so that neither pair is advantaged to specialize after the manner of the hand of man.



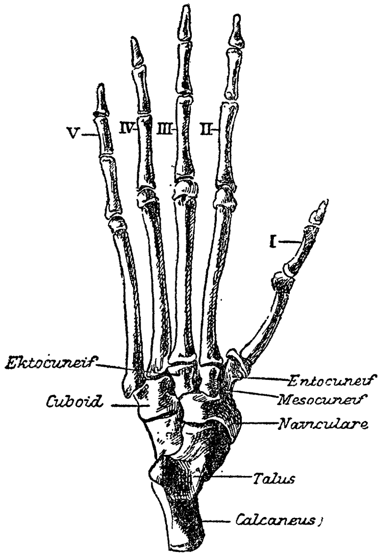
COMPARISON OF THE SKELETONS OF MAN AND THE GORILLA, presenting especially marked differences in skull and proportions of anterior and posterior limbs. Skeleton of gorilla to left; skeleton of man to right. (Adapted.)

The distal or foot portion of the posterior extremity of both ape and man represents in its fundamental plan the typical extremity of all vertebrates above the fish. It has the same elements arranged in the same order with relation to each other. It is characterized as in normal mammals and reptiles by five digits or fingers in which the inner or first digit corresponds to the thumb and is composed of a smaller number of phalanges or finger bones than the other digits.

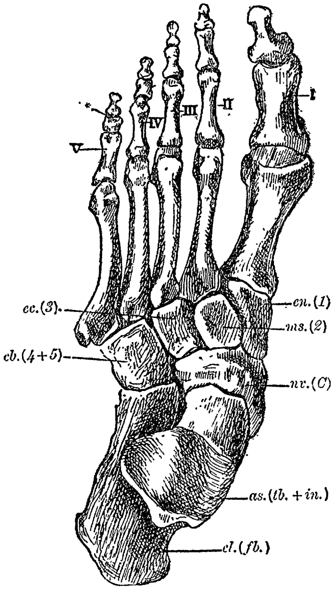


Gibbon. Illustrating extraordinary difference between posterior and anterior limbs. (Adapted.)

In the apes the first digit is, as in normal mammals and reptiles, much shorter than the other, but is distinguished by ex-



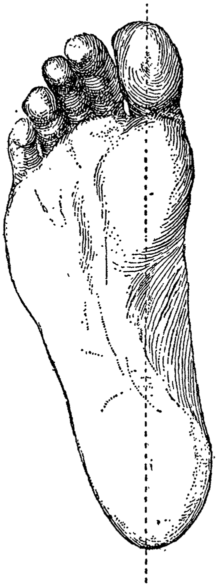
Left foot of Chimpanzee.
(Adapted from Wiedersheim.)



Left foot of Man.
(Adapted from Wiedersheim.)

traordinary mobility including opposability to the other digits as seen in the thumb of the human hand.

In the foot of man, with the same fundamental plan seen in the apes, we find an extreme modification rarely duplicated in vertebrates, in that the normally short first digit, while retaining the normal number of phalanges for mammals, has been greatly enlarged and elongated until it equals or exceeds the longest of the other digits. It has, moreover, relatively very slight mobility and is not in any sense opposable. The type of modification is so extraordinary among the great number of foot forms known that we must assume for it an important relation to an extraordinary use. This we find indicated in the unusual position of the fore and aft axis of the foot, running obliquely across the foot and through the great toe, instead of through the middle toe as in most forms, giving us a foot with the toes turned out, the weight of the body being borne very largely upon the end of the inner toe. This extreme modification of the human foot is clearly to be coupled with the specialization of the whole limb for running in a long-legged, two-footed form, standing normally with everted toes.



SOLE OF HUMAN FOOT. (Adapted from Munson.)

According to the paleontologist who relates variation in form to variation in use, these peculiar characters of human feet have come to exist through peculiar use, persistently continued for a long period. It seems that we must set the human type off as very unusually modified for the special function of bipedal locomotion so necessary if the hands are to be set free to serve the head.

Although in the view of many of the earlier writers the human foot differs but little from that of the apes, a number of investigators have inclined toward the view that the differences seen here constitute one of the strongest evidences indicating a considerable gap between man and anthropoids. The separation has seemed sufficiently wide to indicate that the initiation of changes leading toward the human type of extremity must have occurred at a very remote time, at least as early as the incipient specialization of the ape group, tending to produce its peculiar type of adaptation for aboreal life through use of the anterior limbs for swinging or climbing with the hind limbs used for grasping.

In his recent careful review of the subject, Dr. W. K. Gregory takes another view, namely, that the human group may be derived from an anthropoid type which had gone far in the direction of arboreal specialization, and later left the trees and passed through relatively rapid evolutionary stages, producing a long-legged running type with greatly developed big toe. According to Gregory the erect position of man has been made possible by great elongation of arm, permitting fairly erect position of the body in an anthropoid ancestor who rested his weight in some part upon the fore limbs in walking, as in the modern gorilla.

To most students of the problem of structural similarities and differences distinguishing apes and men, the greatest divergences noted are to be classed as differences in degree rather than in kind. This seems in large measure true of skull and brain. The difference in foot structure possibly presents the widest separation and indicates distinction in habits of life conditioned upon locomotion. Should the views expressed by Gregory prove correct, man might conceivably be derived with changes of relatively little significance from forms not unlike the most man-like of modern apes. If other views offer the correct interpretations of structure and of possibilities of modification, the gap is wider and the modern apes will be assumed to represent a type built especially for the trees, while man will be considered as a type long practised in running, long accustomed with free hand to serve a brain given wider opportunity for range of thought. Yet even with this widest gap that we can open the apes are still so near us that with man recognized as a biological type he must, when classified, take his place in the line next to the chimpanzee and the orang.

Conclusions as to Position of Man in Nature

The conclusion which we obtain from a consideration of the biological aspects of the human problem is that physical man may not be separated from the zoological scheme. The sum of evidence from human physical structures gives us an organism dependent upon typical biological processes for its origin, and constructed on the typical mammalian plan. On the basis of general similarity we are obliged to refer the type to that portion of the mammalian group including the monkeys and apes. Such evidence as we secure from comparative anatomy, interpreted through the study of classification and distribution, suggests that the type of man is built up from a form which was originally reptilian, and has passed through many mammalian stages before reaching its present level of development. We find the human race showing grouped variations of individuals apparently separated from other variations much as are a large percentage of the generally recognized species of many groups of mammals. We find also that the varying individuals are geographically grouped in a manner paralleling the distribution of mammalian types recognized as species and genera.

From the fact that man is differentiated into clearly separated groups related geographically as are the species of mammals, one might assume that he has been subject to the laws of evolution obtaining in other groups of organisms, and that through a long course of history he has gradually spread himself over the earth, undergoing a process of differentiation concurrent with the extension of his geographic range. In this brief statement, it is not necessary to go farther into consideration of the physiological organization of man than to state that, excepting in minor details, the functioning of this organism is similar to that of the higher mammals of the primate division. The details of physical difference between man and the primates are less than the difference between primates and other groups of mammals assumed to be derived from more ancient forms also ancestral to the primates.

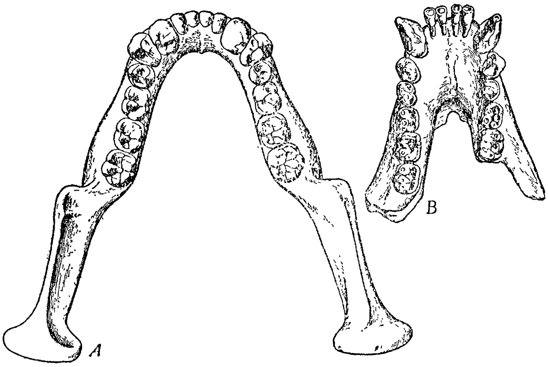
GEOLOGICAL HISTORY OF THE ANTHROPOIDS TO WHICH MAN SHOWS CLOSEST RESEMBLANCE

A most interesting chapter in paleontologic evolution, which is necessarily a preliminary to discussion of early human history, is that covering the successive stages of development of the anthropoids to which man shows closest resemblance. If man is considered to be derived from apes, it is necessary to know whether the assumed ancestor existed before man appeared. It is also in many respects as essential to trace the evolution of these hypothetical ancestors up to the branching off of man, as it is to trace man back toward the type from which he is presumed to be developed. Out of the record of anthropoid history it is to be expected that we shall ultimately obtain most important evidence bearing upon the question of man's relationship to the other mammals.

Unfortunately, the available remains of fossil apes are exceedingly fragmentary and include only a limited representation of skeletal parts. Important specimens have been secured from a few localities in Europe, from northern Africa, and, most significant of all, from the great series of Siwalik formations of southern Asia, representing a large portion of the later geological record. The occurrences of this group in the Siwalik beds of northern India are of unusual importance, as the formations are of considerable geographic extent, of extraordinary thickness, of long geologic range, the relations of the strata are fairly clear, and there is a splendid representation of a long sequence of mammalian faunas associated with the anthropoids. Study of the Siwalik deposits has been followed through the work of the Geological Survey of India for many years, and most interesting results have been secured, especially by Lydekker and Pilgrim. No remains of anthropoids are certainly known from the western hemisphere.

The primate or man-monkey group was in existence, clearly defined, considerably differentiated, and widely distributed in Eocene time, five periods before the present day, or at the beginning of the stage of dominance of the great mammal group. The anthropoid or ape division of the primates was distinctly represented in Africa in the second or Oligocene period of the mammal age. By the middle of the third or Miocene period, forms having in general the characteristics of the orang and the gorilla are found in Asia, and a representative of the gibbons was present in Europe.

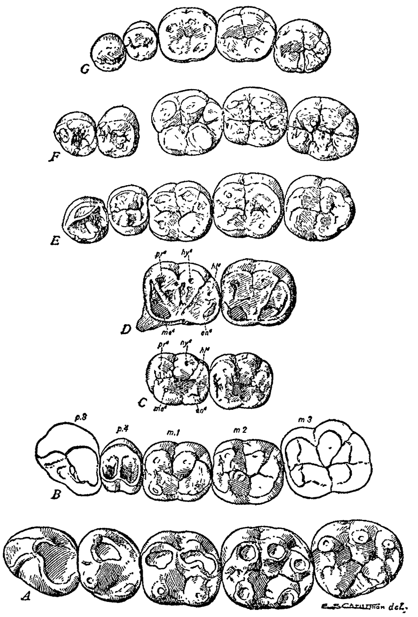
Although the known fossil remains of anthropoids are fragmentary, the available material is sufficient to show distinctly a considerable range of forms in which there are present characters approaching those of the human type, as well as the diagnostic features of the gorilla and chimpanzee. Pilgrim basing his views upon recent studies of the Siwalik collections of India



COMPARISON OF *Sivapithecus* AND *Dryopithecus*. Lower jaws, upper view, multiplied by one third. *A, Sivapithecus indicus,* provisional and partly hypothetical restoration after Pilgrim; *B, Dryopithecus fontani,* after Branco. (Figures adapted from W. K. Gregory.)

has taken the view that the genus *Sivapithecus* of the middle Miocene is very close to a line leading to the earliest known human types and also represents the gibbon group.

Of the forms in the middle and late Miocene stage the group of species gathered under the name of *Dryopithecus* has been held by a considerable number of investigators to stand nearest to man. In his admirable work on the evolution of the primates Dr. W. K. Gregory has recently considered *Sivapithecus* as closely related to *Dryopithecus* and a representative of the Simiine or orang-chimpanzee-gorilla group, rather than of the gibbons. The characters of the dentition and form of the jaw of *Sivapithecus* and *Dryopithecus* approach closely to those of the earliest types referred to the human group.

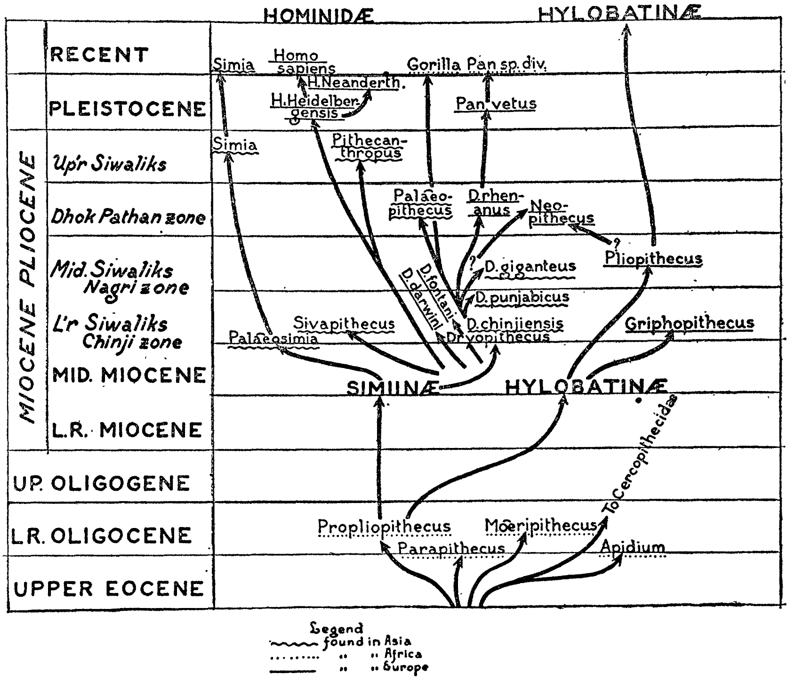


Comparison of Cheek Teeth from the Lower Jaw of Primitive Men and Anthropoids, crown views about three quarters natural size. *A,* gorilla; *B, Sivapithecus indicus,* after Pilgrim; *C, Pan* sp., after Miller; *D, Pan vetus,* adapted from A. Smith Woodward; *E, Homo heidelbergensis,* adapted from Schoetensack; *F, Homo sapiens,* molars of old female Australian black; *G, Homo sapiens,* from a Strandolooper Bushman. (Figures adapted from W. K. Gregory.)

Taking the sequence of anthropoid forms as we know it, we find that in the earlier portion of Cenozoic time only relatively simple types are known as *Parapithecus* and *Propliopithecus* in which there are foreshadowed characters of both the typical anthropoid and gibbon types. In middle and late Miocene the gibbon becomes distinctly separated from the true apes, and there appears a group of several genera including characters of orangs, chimpanzees, gorillas and humans. As we proceed through the Cenozoic these groups become sharply defined, until by the end of the Pliocene they are clearly separated as at the present time, and in their development have passed through stages from some one of which the line of evolution to man many well have originated.

A number of exceedingly fragmentary fossil specimens from America doubtfully referred to the anthropoid group are generally presumed to represent members of the Suidæ or pig family. Inasmuch as we are just beginning to obtain a knowledge of the Pliocene, which is the critical period in consideration of earliest human history, and since the American assemblages in which the doubtful anthropoids appear are in many respects close to faunas of Asia and Europe in which anthropoids occur, it is not impossible that members of this group may yet be recognized in the latest Miocene and Pliocene of North America.

The extraordinary and interesting views of Dr. Florentino Ameghino concerning the possible origin of man by way of evolutionary stages leading through the South American platyrrhine monkeys seem not to be founded upon good logic, as these forms are fundamentally distinct in dentition and general skeletal structure from the Hominidæ or human family and from the whole old world group of anthropoids.



Geological succession and provisional lines of descent of Man and Apes. (After W. K. Gregory.)

Of all the remaining unsolved problems of evolution one of the most important seems to rest in the working out of the later paleontologic history of the anthropoids, particular consideration being given to possible relationship of these forms to the earliest humans. As nearly as we can now determine, the Asiatic region has seen a large part of the evolution of the apes, and contains also the oldest known remains of man. If man has been derived from anthropoids, the chain of missing links required to establish this biological relationship is presumably to be found there.

The 16,000-foot thickness of the Indian Siwalik series presents a most important volume of record in which anthropoid history is written, and no conditions for preservation of remains are more favorable than those of this region. It is not too much to expect that the next ten years of concentrated, well-organized effort in the Asiatic region will furnish as yet undreamed chapters in history giving early tendencies of evolution toward human characters, and evidence on the structure, relationships, habits and environment of earliest man. The undertaking will require much energy and large support, but when other problems of immediate urgency have been satisfactorily settled, it is to be hoped that this work may be carried through. It must be done by more intensive collecting in the known areas, and by a wide range of studies through other occurrences of the late geological formations found over large districts of the Asiatic region. There seems no doubt that some of the most important sources of material have as yet scarcely been examined. Concentrated effort by cooperation of a number of research institutions, or through considerable endowment by one institution operating through a series of expeditions would unquestionably contribute very largely to our knowledge of this most interesting phase of the evolution problem.

(To be continued)